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LETTER TO THE EDITOR FOR INT J LIFE CYCLE ASSESS

Comparing green structures using life cycle assessment: a potential risk for urban biodiversity homogenization?

Alexandre Henry · Nathalie Frascaria-Lacoste

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Against a background of urban sprawl and global climate change, the eco-design of districts has become a common practice. Indeed, in many French and European cities, projects for eco-districts that are based on the three pillars of sustainable development, namely economy, society and ecology, have been established. Different urban morphologies have been proposed for these eco-districts, as well as the use of various technical options such as low-energy or positive-energy buildings, low-impact transportation, and water and waste management. However, these solutions have to be examined carefully in order to achieve results that are in line with the original objectives beyond this design approach. Life cycle assessment (LCA) constitutes an aid to the design of districts that involves evaluation of the overall environmental impact of a project throughout its lifespan (Forsberg and von Malmborg 2004; Norman et al. 2006; Popovici and Peuportier 2004). LCA addresses environmental impacts at a global level, including those associated with the fabrication of construction materials, and energy and transport processes.

A recent paper (Ottelé et al. 2011) featured a discussion of comparative LCA between a conventional built-up European brick façade, a façade that was greened directly, a façade that was greened indirectly (i.e. supported by a steel mesh), a façade covered with a living wall system based on planter boxes and a façade covered with a living wall system based on layers of felt. The aim was to ensure that the positive quantifiable aspects of vertical greening surfaces are also associated with a lower environmental impact during the lifespan of greened buildings (Ottelé et al. 2011). In addition to the environmental benefits of the four greening systems, the research evaluated whether these systems were sustainable in view of the materials used, maintenance, and nutrients and water needed. By its comparison of different greening systems, this work has identified new scientific directions that can reduce the environmental costs of the construction. It is likely that further studies will build on this foundation. In the present letter, we would like to highlight the risk in comparing LCAs, as described by Ottelé et al. (2011), of moving towards homogenization of biodiversity in urban elements by a focus on key green materials that are identified to be environmentally advantageous.

Urban ecosystems are rich in biodiversity but are threatened by urbanization, fragmentation and the destruction of habitats. The species richness is due to the fact that many cities have developed in heterogeneous landscapes at the junction of different habitat types (Kühn et al. 2004). The cities are themselves highly structured (Niemela 1999) and have microclimates that enable a large range of species to thrive (Sukopp and Starfinger 1999). The substantial richness in plant and animal species in cities is due to the wide variety of habitats, to the variety of types and intensities of land use and to the large number of microhabitats that result from the diversity of materials used for the construction (Kühn et al. 2004). Cities should not be barriers to animal and plant species, but rather ecological networks that are connected to natural areas in their surroundings. Consequently, land use in urban areas has a strong influence on biodiversity. In the future, urban configurations that support ecosystem processes and promote resilience will be required (Colding 2007). In cities, ecological land use complementation (Colding 2007) may involve the clustering together of an extensive range of different green patches to increase the available habitats and promote ecological processes (Henry and Frascaria-Lacoste 2012). As Colding (2007) stated, ecological land use complementation has potential benefits for biodiversity by increasing the availability of habitats for

A. Henry (✉) · N. Frascaria-Lacoste
UMR 8079, Laboratoire Ecologie Systématique et Evolution, AgroParisTech,
Bâtiment 360, Université Paris Sud,
91405 Orsay Cedex, France
e-mail: alexandre.henry@u-psud.fr

species and by promoting landscape complementation functions and critical ecosystem processes. For effective complementation, the landscape must be composed of a sufficient variety of types of patch to enable all species to realize their complete life cycle. An increase in the amount of different green spaces (parks, gardens, intensive green roofs, green walls, and street trees) provides species with a greater number of potential places in which to live. Thus, the challenge for the design of future cities is to combine a sufficient number of different green elements in an optimal way.

The industry of the production of green building materials is emerging currently. However, the labelling of green material is disparate and complex (Rajagopalan et al. 2012). In addition, consumers are suspicious about the environmental claims of manufacturers (Rajagopalan et al. 2012). Given these difficulties, some researchers (Ottelé et al. 2011; Rajagopalan et al. 2012) have investigated the potential use of LCA in developing product labels for green building materials. The adoption of LCA analysis for the labelling of green products has the potential to boost the confidence of consumers in such products, and thus could increase their use in residential buildings. A recent paper (Ottelé et al. 2011) calculated the environmental impact of the production, use, maintenance and waste of the four vertical greening systems in relation to their benefits. Their conclusions, albeit drawn with certain caveats, were to favour systems that are associated with lower energy demands in their establishment and maintenance (Ottelé et al. 2011).

We completely agree that LCA: (1) has the potential to guide the development of green products and their labelling systems, even if further works are required to confirm the sustainability of them (such as improvement of air quality or mitigation of urban heat); (2) can help to provide more information about products to the consumer and (3) could help in the making of decisions about purchases of green elements that are good for environment. Nevertheless, the use of LCA could lead to particular focus being placed on specific green elements, while others are overlooked, and thus could lead to many buildings that use the same green elements being designed. Consequently, this could potentially further homogenize natural features within cities and have a negative impact on biodiversity functioning. Therefore, we suggest that the scientific community should be careful with respect to the use of LCA comparisons for the design of, and decision-making regarding, green surfaces within towns. Other tools that could integrate land use complementation into urban planning, for example, are also needed to create conditions that improve the life cycle of biodiversity. Hence, there appears to be a strong need for a compromise between what is desirable for biodiversity, what is economically feasible, what is environmentally attainable and what is acceptable to the people in a given city.

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